Raychem

PolySwitch® Resettable Fuses for Circuit Protection

General Electronics

PolySwitch

Raychem

PolySwitch®

Circuit Protectors

Resettable 'fuses' that offer improved safety and reliability for a broad range of electronic equipment

PolySwitch circuit protection devices protect electrical and electronic circuits against excessive current, voltage, and temperature. Applications include:

- Instrumentation and control
- Security systems
- Medical equipment
- Batteries
- Computers and peripherals
- Audiovisual equipment
- Toys
- Telecommunications networks
- Modems
- Transformers

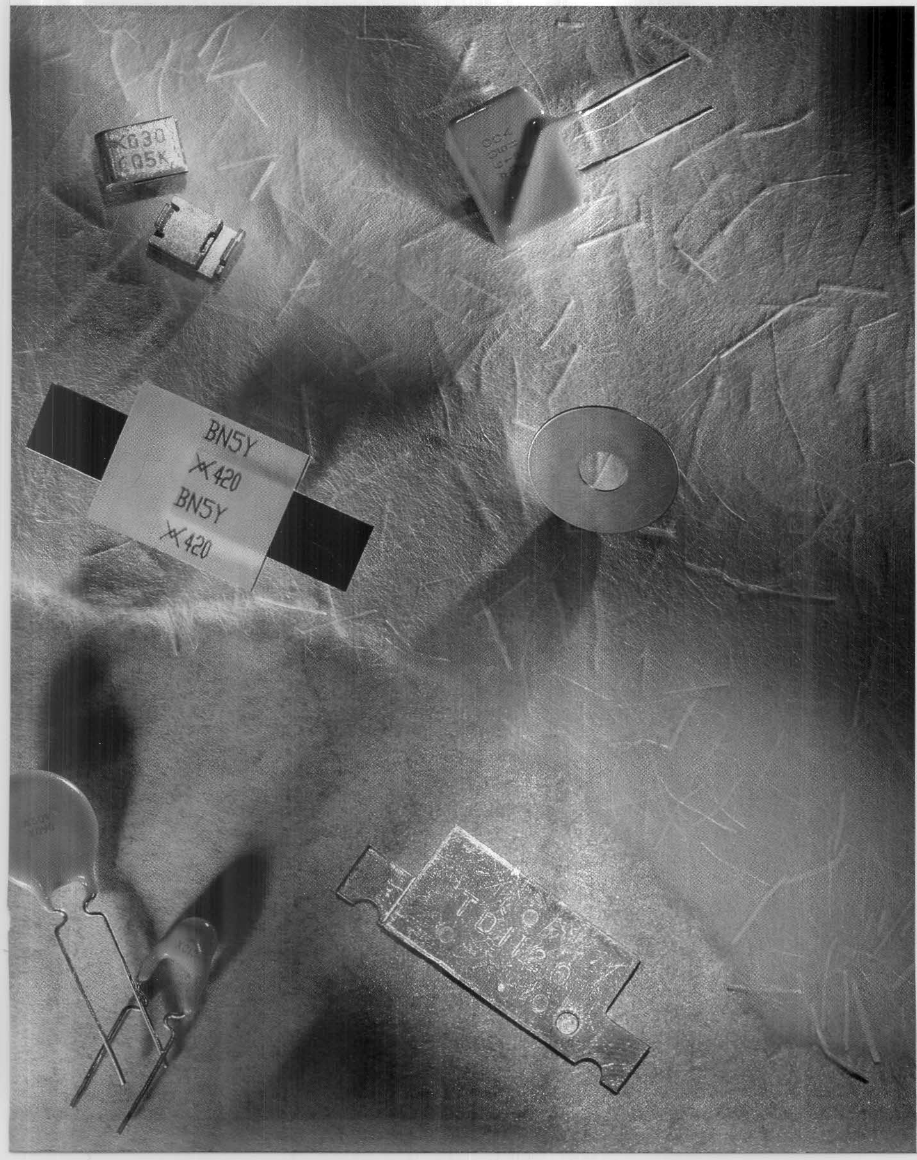
Like fuses and circuit breakers, PolySwitch devices interrupt the flow of dangerously high currents, whether due to excessive voltage or to a fault condition within the circuit. But unlike fuses and circuit breakers, PolySwitch circuit protectors automatically reset themselves after the fault that caused them to trip is corrected.

PolySwitch devices are positive temperature coefficient (PTC) resistors that rapidly increase resistance in response to excessive currents or temperature. When the current flowing through a PolySwitch circuit protector is within its maximum rating, its "base" resistance is very low. If the current rises above its rated current, the PolySwitch device's resistance abruptly rises. Then, as circuit resistance is increased, the current decreases until thermal equilibrium is achieved.

Depending upon the PolySwitch model and the amount of current, the trip time required to reduce the current can be as short as one-tenth of a second. Once power to the protected circuit is removed, the PolySwitch device's resistance begins to drop towards its normal value, in essence resetting the device so that normal operation can resume when the fault is corrected and the power reapplied.

PolySwitch devices have distinct advantages over other methods of circuit protection:

- Remotely resettable, they can automatically reset themselves thousands of times, thus eliminating unnecessary product downtime.
- Low resistance means low voltage drops in power circuits.
- Components are UL recognized. CSA component acceptance and TUV licensing are approved or pending.
- Radial-leaded and surface-mount packaging make installation easy.



PolySwitch resettable "fuses" come in a variety of form factors to meet most application and installation needs.

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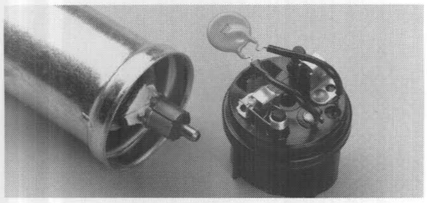
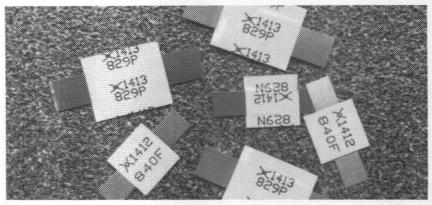
POLYSWITCH PROTECTORS IDEAL FOR DC MOTORS



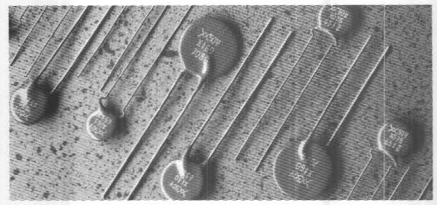
Solid-state PolySwitch PTC resistance devices from Raychem provide resettable overcurrent and overtemperature protection for DC motors. The devices are widely used in automotive motors and actuators that control power door locks, windows and seats. Other applications include solenoid and motor protection in computer peripherals, ATM machines, and cooling fans. PolySwitch devices have no moving parts, no contacts to arc, are insensitive to vibration and can be custom designed.

OVERCURRENT PROTECTION FOR BATTERY PACKS



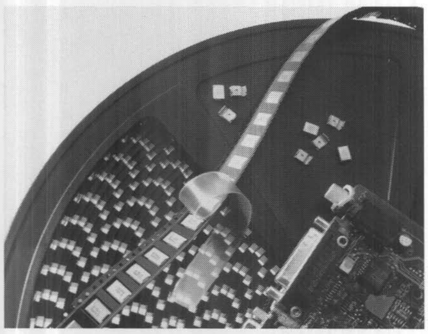
Designed specifically for NiCad batteries, Raychem's new line of PolySwitch PTC resistance devices provides resettable discharge-overcurrent protection in a package that can be welded directly into battery packs. The new devices offer higher current ratings in a smaller size than previously available, and can be used over a wider temperature range.

POLYSWITCH RXE FAMILY HAS WIDE RANGES OF USES



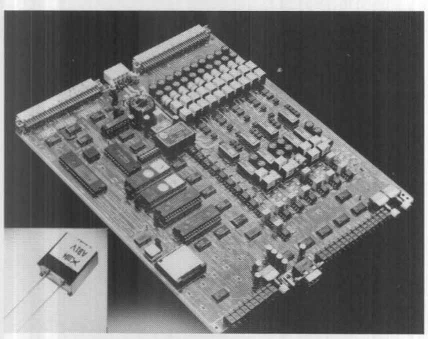
The RXE general-purpose line of PolySwitch circuit protectors from Raychem is well-suited for power supplies, alarm systems, speakers, motors, telecommunications and many other applications. The durable devices handle normal currents from .10 to 3.75 amps and are rated at 50 or 60 volts. They require no manual resetting or replacement, and won't damage circuits by continuously cycling. Some devices are available on tape-and-reel for auto insertion.

RAYCHEM POLYSWITCH SURFACE-MOUNT DEVICES PROTECT COMPUTERS, LANS



PolySwitch surface-mount PTC resistance devices from Raychem Corporation provide reliable, resettable circuit protection for computers and local area networks. Installed on printed-circuit boards in the DC power-feed circuit, the devices protect computer and communications equipment in the event of an electrical fault or overload. Because they are resettable, PolySwitch protectors eliminate the problem of blown fuses and related equipment repairs.

RESETTABLE TELECOMMUNICATIONS PROTECTION, UL 1459 APPLICATIONS



Raychem's PolySwitch devices provide resettable overcurrent protection in telephone interface applications. When an overcurrent hazard happens on a tip/ring interface, PolySwitch devices effectively limit current, then return the circuit to normal operation once the fault subsides. When used in appropriately designed tip/ring circuits, PolySwitch devices allow telecommunications equipment to meet UL 1459, the customer-premises telephone equipment safety standard.

If a fuse could replace itself, it would be a PolySwitch® PTC.

Nothing beats a fuse for stopping overcurrent.

Once.

But a PolySwitch® circuit protector can do a fuse's job over and over without replacement. So it not only saves your product from surges. A PolySwitch device gets your product humming again in seconds.

It accomplishes this with a technology that's so elegant it makes even a fuse look overengineered. When a current overload hits its conductive polymer compounds, the PolySwitch PTC (positive temperature coefficient) device warms and turns non-conductive. Lower the current and the device's conductivity resumes.

PolySwitch PTCs never need manual resetting or replacement. So you never use the wrong replacement fuse.

PolySwitch devices are monolithic, testable, board-mountable, and small. Whereas fuses are small, period. And PolySwitch PTCs are available in hundreds of optimized designs—for everything from rechargeable batteries to telephones to stereo speakers.

Finally, PolySwitch PTCs are from Raychem. So they're reliable and backed by experience and support that never shuts off.

Call for a free sample and more information. Because PolySwitch PTCs could be just the replacements your fuses need.

Raychem

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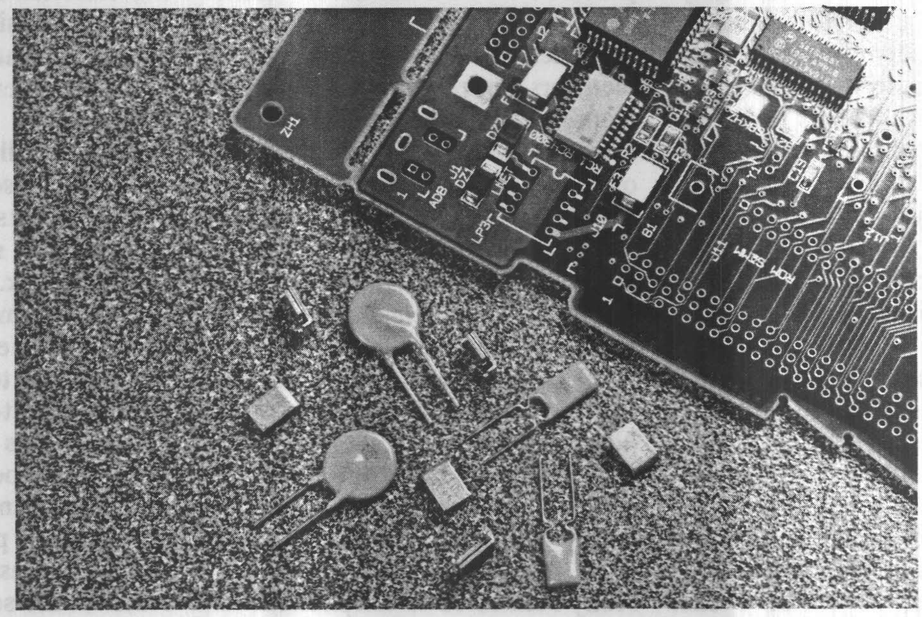


CONDUCTIVE POLYMERS PROLONG CIRCUIT LIFE

Resistors act as self-resetting fuses

Tony Fang and Stephen Morris,
Senior Engineers,
Raychem Corp., Menlo Park, CA

If your design demands a compact, service-free alternative to fuses and similar circuit protection devices, check out conductive polymer positive temperature coefficient (PTC) resistors.

As their name implies, PTC resistors provide circuit protection by quickly and significantly increasing their resistance when an overcurrent condition develops. By increasing their total resistance, PTC resistors decrease the current to a level too low to cause further damage to the protected circuit.

When power is removed, the PTC's resistance returns to a value low enough to permit normal circuit operation. Unlike fuses, PTC resistors provide a long-term solution in that they ordinarily do not require servicing or replacing.

Polymer protection. Conductive polymer PTC resistors are solid-state devices small enough to fit into surface-mount packaging, and rugged enough to withstand rough handling. Available off-the-shelf in the form of Raychem Corp.'s PolySwitch® circuit protectors, they can replace fuses, circuit breakers, and thermostatic switches in many applications.

Because of the dangers associated with supplying power to peripherals through I/O ports, U.L. Standard 1012 requires that power connections in computer ports be protected against excess current. Most computer manufacturers use fuses for this purpose, but not Apple Computer, Cupertino, CA. Instead, Apple chose to use PolySwitch devices to protect I/O ports on its Macintosh desktop computers.

The protected ports—used to connect an external keyboard, mouse, disk drive, and SCSI devices to the motherboard—supply electrical power to the outside world. Any power-related fault on the output side of the port, such as the accidental use of an incorrectly configured cable, could easily cause excessive current to flow through the port. If the current is

high enough, it could severely damage the expensive motherboard.

Protecting telephones. PolySwitch circuit protectors also see service in a variety of telephone applications. Northern Telecom, for example, uses them in its Vista telephone set to protect against excessive current. Current limiting is necessary because power transients induced onto telephone lines can drive enough current into the customer's equipment to damage it.

Of greater concern: Power crosses. As the name implies, a power cross is an unintentional cross-connection between a telephone line and a power line. It usually results from a telephone pole being knocked down or from a snapped power line falling onto a telephone line. In either event, enough current can be driven into equipment connected to the telephone line to start a fire.

The danger posed by power crosses is great enough that U.L. Standard 1459 requires overcurrent protection of all on-site customer equipment. Like computer makers, most telephone equipment manufacturers comply with U.L. 1459 by installing fuses or fusible resistors. Because a service technician is often needed to replace a fuse in a telephone set, users find it more convenient to replace the equipment. By using PolySwitch protectors in its Vista telephones, Northern Telecom complies with U.L. 1459, while the customer saves a call for a technician or the cost of new equipment.

Backing up batteries. Portable cellular telephones, an emerging major worldwide product, also require protection. Although not directly connected to telephone lines, portable telephones are likewise a potential fire hazard.

The problem is not with the telephone, but with the battery that powers it. Because the battery is small and lightweight, it has limited power. To extend talk time, most portable cellular telephones use removable battery packs that permit replacing an exhausted battery with a fully charged battery.

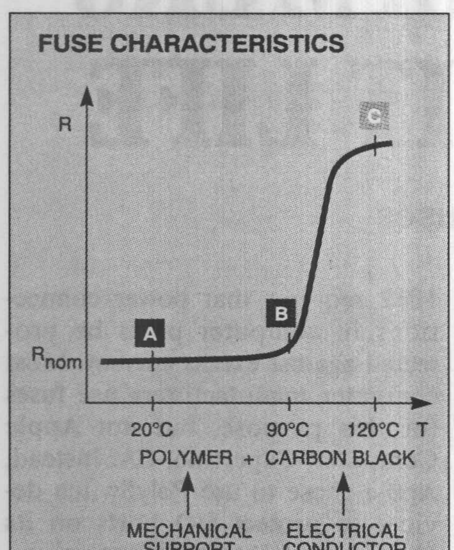
Often these extra battery packs are carried in a pocket, briefcase, or luggage. Here, their exposed terminals can come in contact with loose change, keys, or jewelry. If a short circuit develops across a charged battery pack's terminals, very high current can flow. Depending on the physical and electrical characteristics of the material creating the short circuit, it could get hot enough to ignite surrounding material. Enough heat could be generated inside the battery that it violently vents itself. At the very least, such venting can destroy the battery pack.

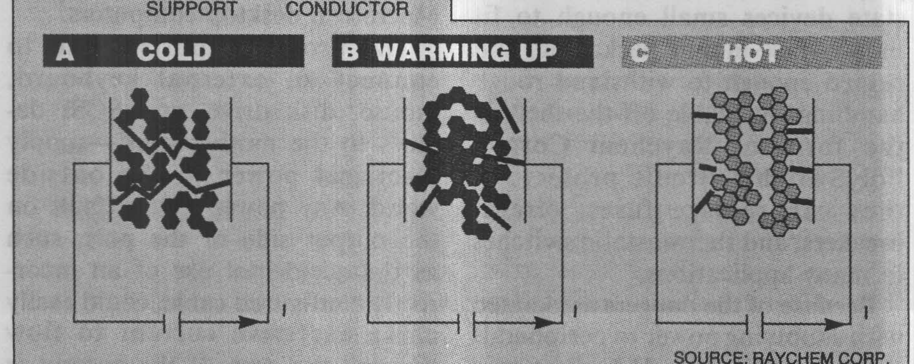
Traditionally, battery-pack makers protect users against accidental short circuits with one or more thermostatic switches installed inside the pack. These switches consist of a bimetallic element connected in series with the power line. Heat generated by the excessive current distorts the element's shape. As this distortion occurs, the contact set opens and interrupts the flow of current.

While this provides positive protection against overcurrent, it also removes the source of the heat that causes the contact set to open. As the bimetallic element cools, it returns to its original shape, closing its contact set and permitting the short-circuit current to flow. This, in turn, causes the contact set to reopen. Such cycling can damage the battery.

Of greater consequence, continual cycling can lead to contact damage. In some cases, the contact set actually welds shut, defeating the purpose of the thermostatic switch. As a result, the short-circuit current flows continuously.

Motorola decided to avoid these problems by using PolySwitch circuit protectors in the battery packs for its portable cellular telephones. PolySwitch devices have no contacts to weld shut. Also, once acti-





At normal temperatures, conductive particles form low resistance chains in the polymer. Any rise in current increases the power dissipated within the PolySwitch. As the temperature rises, the conductive polymer begins to change from its normal crystalline state to an amorphous state. The increase in resistance substantially de creases the current flowing through the PolySwitch, protecting the circuit from damage. Unlike fuses that must be replaced when they blow, PTC resistors form a permanent solution.

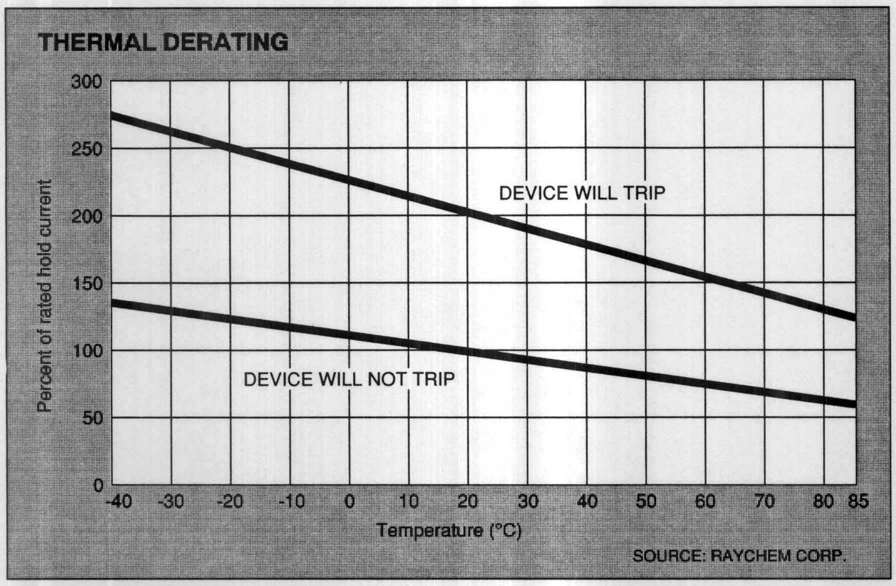
vated, the protectors latch in their high-resistance mode until power is removed from the protected circuit, eliminating periodic cycling.

Automobile applications. The ability of PolySwitch protectors to latch in their high-resistance mode is a key reason automobile companies use them to protect small motors that drive power windows and door locks. Guarding a motor against overcurrent is extremely important. The motor could stall and a person might absentmindedly continue to press a control button after the window has fully opened or closed. Also, a child might hang onto a window while it is being closed, possibly causing the mechanism to jam.

Once again, fuses are the traditional way to protect these small drive motors. Because of space and economic restraints, most fuses protect more than one circuit—separate motors used to power door locks and windows, for example. If the fuse blows, all the door locks and windows become inoperative.

In fact, many incidents have been reported where occupants became trapped inside their vehicles when they could not open doors or windows due to blown fuses. Because PolySwitches never need to be serviced or replaced, they can be located inside a vehicle's doors, enabling each motor to be protected individually. Even if one motor becomes inoperable, the other motors can continue functioning.

Design considerations. To properly characterize a circuit protector, the consequences of potential faults must be determined. This requires an analysis of component damage as a function of fault current and time, as well as the fault itself.



Ambient and device temperatures are especially important for PTC resistor selection. Their performance depends on the difference between the two temperatures. PTC resistors are usually specified at a standard ambient temperature of about 20C. The PTC resistor's current rating must compensate for any differences between the standard ambient temperature and the actual ambient operating temperature.

The analyses should include: source voltage, source impedance, duration of each fault cycle, and the number of potential fault cycles that can occur during a given event. Source impedance is particularly important. If it is very low, very high currents may flow under relatively minor fault conditions.

Even fast-acting fuses let some excess current flow before interrupting the circuit. The current-time product let through by the protection device before it trips must not exceed the maximum permissible current-time product fixed by the damage-profile analysis.

All circuit protectors must carry some current continuously, yet trip when the power rises above a predetermined threshold. In most circuits, the minimum trip current is significantly greater than the maximum carry current. Sometimes the difference between the two is small. In any case, the circuit protector must not change its trip threshold, regardless of its age or the number of times it trips.

When tripped, a PTC resistor's resistance remains so high that a significant portion of the source voltage appears across it. Thus, the PTC resistor's voltage rating must exceed the maximum voltage across it as a result of a fault.

Ambient and device temperatures are important factors in making a PTC resistor selection. Their performance depends on the difference between the two temperatures. PTC resistors are usually specified at a standard ambient temperature of about 20C. The PTC resistor's current rating must compensate for differences between the standard ambient temperature and the actual ambient operating temperature.

Automatic resetability is desirable where cost and inconvenience of replacing a fuse or manual reset prove unacceptable. In general, most bimetallic thermostatic switches reset when the fault is removed; PTC devices reset when all the power is removed.

In some applications, the unique characteristics of a particular kind of circuit protector dictate its use. In most instances, the designer has a choice of two or more kinds of circuit protectors, any one of which can provide acceptable protection. Under these circumstances, cost, size, or installation requirements are the determining factors. □

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Raychem

Application Bulletin

PolySwitch® RUE and RXE Resettable Fuse Devices

Fire Alarm and Security System Applications of PolySwitch Devices

Many fire alarm and security systems incorporate PolySwitch positive temperature coefficient (PTC) devices for overcurrent protection of power supplies and individual components, and to provide circuit safety. By tripping during fault conditions and resetting themselves when the fault is removed, PolySwitch devices provide overcurrent protection without the nuisance and extra service calls associated with fuse replacement. That means reduced product warranty costs.

The problem

Today's fire alarm and security systems can be damaged by high fault currents caused by short circuit conditions or overload conditions. Faults can result when an installer inadvertently shorts out a pair of wires carrying power to remote components. Faults can also occur when the backup battery is accidentally shorted or installed backwards.

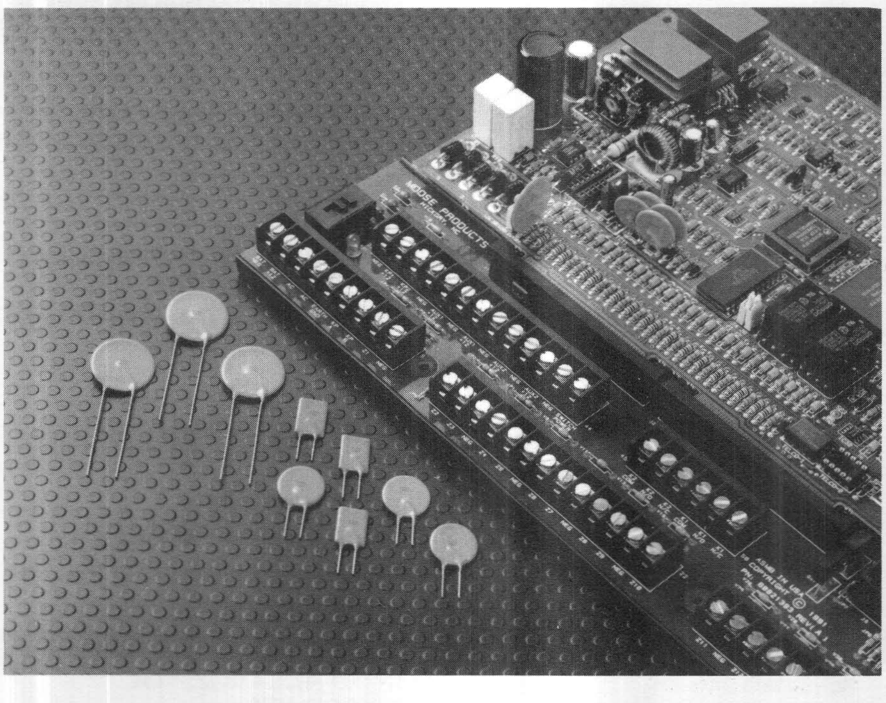
Possible solutions

Underwriters Laboratories (UL) Standard 864 requires that user-replaceable fuses be shorted out during fault current testing. The fire alarm or security system designer considering fuses is faced with a dilemma. By choosing to have no user-replaceable fuses, the customer must have the unit serviced whenever a fuse has blown. Choosing two sets of fuses, one lower current user-replaceable set and one higher current nonreplaceable set, is costly and uses valuable space. The alternative to fuses is the ideal solution to the designer's dilemma: Raychem PolySwitch resettable fuses.

The Raychem PolySwitch solution

Raychem PolySwitch self-resettable fuse devices are made from a conductive polymer blend of specially formulated plastics and various conductive materials. At normal operating temperatures (-40°C to 85°C) these devices have very low resistances (from 5 mΩ to 5 Ω for the entire RUE and RXE PolySwitch lines). During a fault when abnormally high currents are present, the temperature of the PolySwitch device increases and the crystalline structure changes to an amorphous state and expands. The conductive paths within the polymer mass separate, causing a dramatic increase in the device's resistance. This increased resistance reduces to a minimal level the amount of current that can flow under the fault condition. As long as the fault is present, the PolySwitch device will stay in the tripped state and protect the system without cycling.

When the fault is removed, the PolySwitch device quickly cools and contracts. The conductive paths within the polymer mass come back together and normal operation can resume.



PolySwitch RUE and RXE devices offer a cost-effective method of protecting fire alarm and security systems against short circuit or overload conditions.

No operator action is required and no fuse has to be replaced. Since PolySwitch devices reset themselves, they do not have to be accessible or replaceable by the user.

Applications

There are many designs for fire alarm and security systems. Figure 1 shows some possible applications for a typical system. PolySwitch devices are used to protect power supplies and the circuit traces distributing the power to sensors, add-on units, sirens, bells, and keypads. In the example in Figure 1, there are separate PolySwitch devices at each output. The actual scheme used in a particular system will depend on the specifics of that design. Using separate PolySwitch devices on different parts of the power bus provides:

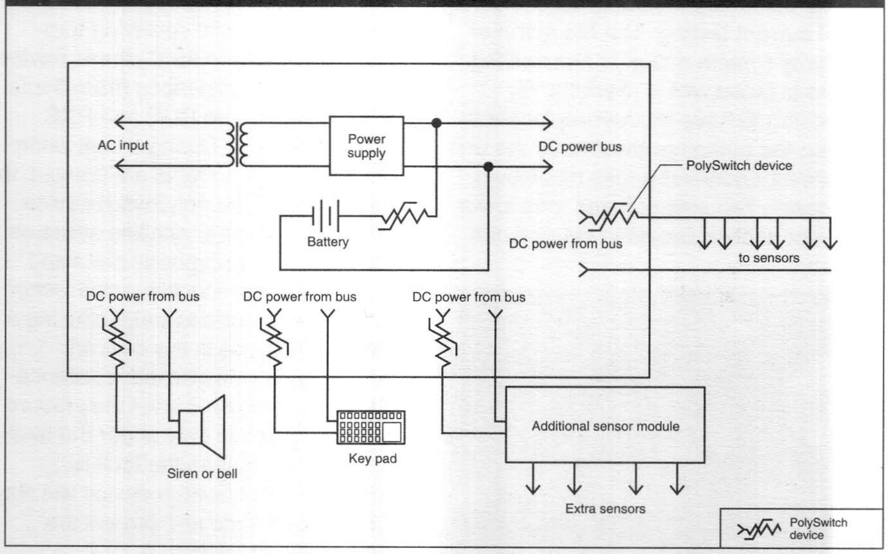
- Resettability—Unlike a fuse, PolySwitch devices can reset themselves once the overload condition has been removed.

- Added Reliability—Different sections of the power bus may have different current handling capabilities. A single circuit protection device may be too large and slow to trip more delicate parts of the circuit, or too small and fast to protect more robust sectors and may cause nuisance tripping. Matching different size PolySwitch devices to the needs of different parts of the circuit helps insure reliability.

- Enhanced Operability—When a fault occurs, only part of the power bus will be affected. The remaining sections will continue to function.

- Ability to Locate and Isolate Faults—Separate PolySwitch devices indicate to the operator what part of the power bus is affected and where the fault might be located. If there were only one PolySwitch device for the entire bus, there would be no immediate indication where the fault was located.

Figure 1: Typical System Power Distribution Using PolySwitch RUE and RXE Resettable Circuit Protection Device



PolySwitch devices are also used in the battery backup circuits. If the battery were shorted out, extremely high currents would flow. Some components will reach very high temperatures and possibly cause a fire. Another danger is the possibility of installing a battery backwards. When this occurs, the battery is now in a short circuit series loop with the power supply, causing the voltages to add. A 12 Vdc system would have a total of 24 Vdc connected to a short circuit. This would result in even larger fault currents than in a simple battery short circuit. The RUE and RXE lines of PolySwitch devices have a 40 amp maximum interrupt current rating, well suited for this type of protection.

Device selection

When selecting a PolySwitch device several factors must be considered: maximum voltage, maximum interrupt current, device resistance, hold current, trip current, and time to trip. This information is contained on the PolySwitch products data sheets.

A PolySwitch device should be chosen to protect the most delicate component in the circuit. The "time to damage" should be greater than the PolySwitch device's maximum time to trip at the lowest expected ambient temperature.

The RUE and RXE families of PolySwitch devices are ideal for fire alarm and security system applications. An SMD family of surface-mount PolySwitch devices is also available.

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Raychem

Application Bulletin

PolySwitch® RXE Resettable Fuse Devices

Loudspeaker Applications for PolySwitch Devices

Many loudspeaker systems incorporate PolySwitch positive temperature coefficient (PTC), devices for overcurrent protection. By tripping during high-current conditions and resetting themselves when no longer needed, PolySwitch devices provide reliable protection without the nuisance and replacement costs associated with fuses.

The Problem

Today's speakers are generally designed and sold independently of amplifiers. Thus, mismatches may occur which can lead to damage. Also, the advent of digital recordings and compact discs places extra burdens on sound systems. Speaker damage can result from a number of factors including:

- High-power amplifiers used with low-power speakers may simply overdrive the speaker coils with excessive power during sustained high volume.
- Low power amplifiers may be over-driven so that clipping occurs. This causes an upward frequency shift of power which can overload the tweeter. This problem is especially common with the wide dynamic ranges found on compact discs.
- Digital recordings, including compact discs, with their ability to reproduce high-frequency material, place extra strain on tweeters.

The protection choices for loudspeaker systems are fairly limited. Fuses will protect the speaker, but a blown fuse will be a source of frustration for the user and may result in field returns for the manufacturer. Also, the addition of a fuse holder and wire so that the fuse is accessible will increase material costs. Because the fuse must be accessible, it can be defeated or replaced with the wrong fuse. Circuit breakers are an alternative method. However, they can arc as they start to open and cause disturbing noise until they are fully open. The best solution for this problem is Raychem PolySwitch devices.

The Raychem PolySwitch Solution

PolySwitch self-resettable fuse devices provide soft switching into a high-resistance tripped state, and automatically reset themselves to a low-resistance state when it is safe to do so. They are made from a conductive polymer blend of specially formulated plastics and various conductive materials. At normal operating temperatures, these devices have very low resistances, (from 30 mΩ to 800 mΩ for the RXE devices typically used in speakers). Therefore, their insertion loss is usually less than 0.1 dB. They have essentially no capacitive or inductive reactance and cause no measurable distortion over the audio range of frequencies. When excessive currents are flowing, the temperature of the PolySwitch device increases and the crystalline structure of the polymer begins to change to an amorphous state and expand.

PolySwitch devices maintain audio quality as they protect loudspeaker systems from overcurrent damage.

Figure 1: Effect on Load Power

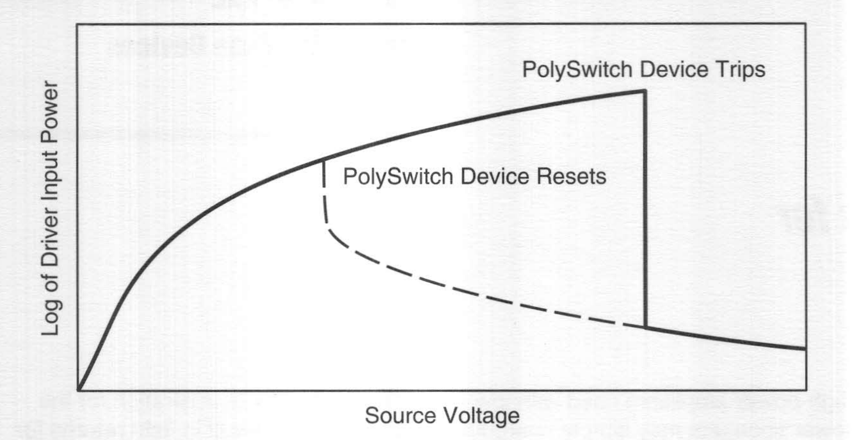
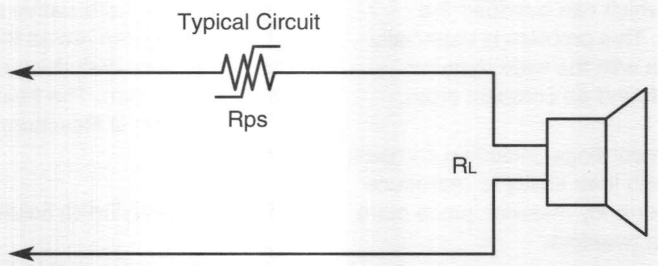


Figure 2: Typical Circuit



Conductive paths within the polymer mass separate, causing a dramatic increase in the device's resistance. This increased resistance reduces the amount of current that can flow to a minimal level. The time it takes for a particular device to trip depends on the amount of current flowing. The resistance of the PolySwitch device in the tripped state (Rps) is typically three to four decades higher than the untripped resistance. Tripped state resistance is determined by the square of the PolySwitch voltage (Vps) and the power dissipation of the device (Pd). Pd is essentially constant for a particular PolySwitch device in the tripped state and is shown on the family data sheet. It can be affected by heat transfer conditions, such as the way the part is mounted or connected, air currents, etc. The formula for Rps when the device is in the tripped state is:

$$R_{ps} = \frac{V_{ps}^2}{P_d}$$

$$R_{ps} \cong \frac{V^2}{P_d}$$

(V is the drive voltage and Vps is the voltage across the PolySwitch device. They can be assumed to be approximately equal for this equation.) As long as the drive voltage is sufficient, the PolySwitch device will stay in the tripped state and protect the system. Figure 1 shows how the load power is reduced by 20 to 30 dB after the device trips. The formula for dB power attenuation in the tripped state is:

$$\text{Atten.} = 20 \log \frac{V - V_{ps}}{V}$$

where:

$$V_{ps} = \frac{V + \sqrt{V^2 - 4R_L P_d}}{2}$$

When the drive voltage is increased, the PolySwitch resistance increases, causing the power output to decrease. When the drive voltage is reduced, the power increases along the dotted line in Figure 1. When the drive voltage is reduced so that the PolySwitch device can no longer draw sufficient power to keep itself in the tripped state, it resets. Since PolySwitch devices reset themselves, they do not have to be accessible or replaceable by the user. The drive voltage at which the PolySwitch device will reset is approximately:

$$V \leq 2\sqrt{R_L P_d}$$

where R_L is the load resistance.

Applications

Figure 2 shows the simplest installation, which consists of a PolySwitch device in series with the driver. The PolySwitch device should be sized so that its time to trip at any particular current is less than the time required to damage the driver at that current.

The circuit in Figure 2 will have the power characteristics of Figure 1.

Figure 3: Shunt Resistor Circuit

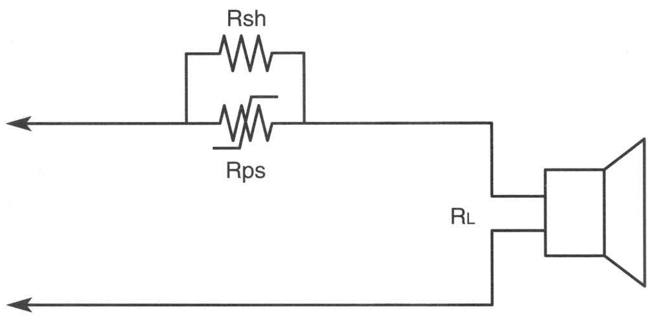


Figure 4: Effect on Load Power-Shunt Resistor

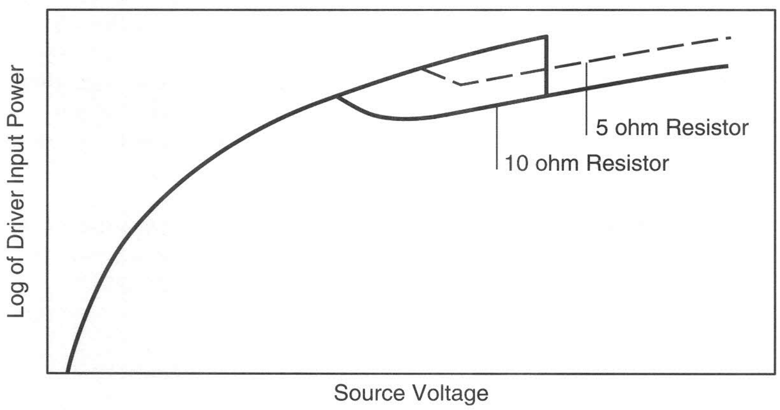
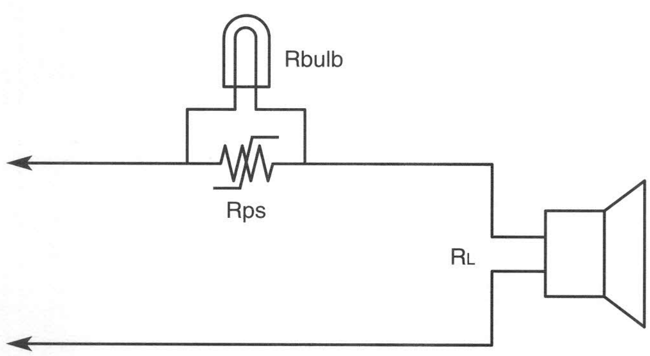


Figure 5: Shunt Light Bulb Circuit



PolySwitch Device with Shunting Resistor

Some designers would like to reduce the drive power by a smaller fixed amount in case of a fault, rather than the large amount shown in Figure 1. Figure 3 shows a sample circuit with a shunt resistor in parallel with the PolySwitch device.

Figure 4 shows the load power characteristics for a 5Ω and 10Ω shunt resistor.

Now, the dB power attenuation when the PolySwitch device trips is approximately:

$$\text{Atten.} \cong 20 \log \frac{R_L}{R_L + R_{sh}}$$

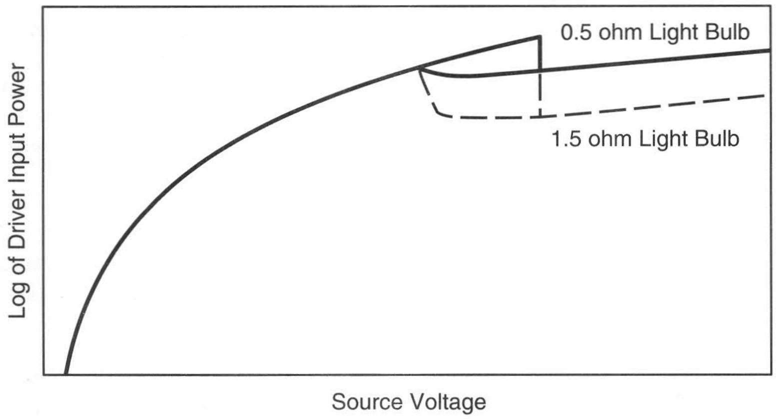
where Rsh is the value of shunt resistance. The approximate source voltage at which the PolySwitch device resets in this case is:

$$V \leq 2R_L \sqrt{P_d \left(\frac{1}{R_L} + \frac{1}{R_{sh}} \right)}$$

PolySwitch Device with Shunting Light Bulb

A third method is to use a shunting light bulb in parallel with the PolySwitch device. As with the shunting resistor, the PolySwitch device normally carries most of the current. When the PolySwitch device trips, most of the current now passes through the light bulb. As the bulb filament lights and heats it exhibits a PTC effect, (about 1 decade of resistance increase). As with the fixed shunt resistor, increases in drive voltage will increase load power. However, the PTC effect of the light bulb causes this increase to be much flatter than the increase seen with the fixed shunt resistor. The result is less of an increase in speaker power as the volume is increased.

Figure 6: Effect on Load Power - Shunt Light Bulb



The same equations for dB attenuation and reset drive voltage for the fixed shunt resistor apply for the shunt light bulb. The value for shunt resistance now depends on a complex balance between the PolySwitch device resistance and light bulb resistance.

The light bulb is typically used only for its PTC effect, but it can also be used as an overload indication to the user. An LED in series with a resistor can also be used as an overload indication, but it does not have any PTC effect.

The choice between the various sizes of shunt resistance, light bulb, or the choice to use nothing at all in parallel with the PolySwitch device depends on the protection philosophy of the speaker designer. Components can be chosen so that the user immediately hears the attenuation when the PolySwitch device trips. Alternatively, components could be chosen so that the user never hears an attenuation, just a reduced volume increase as he or she turns up the volume control after the PolySwitch device has tripped.

Device Selection

Deciding which part to use must be based on a knowledge of the specific protection needs of the driver. An analysis of the time it takes to cause damage for various drive currents would be very useful. For effective protection, the PolySwitch device time to trip curve at the lowest expected ambient temperature should lie below the driver time to damage curve. If a complete time to damage curve for the driver is not available, the designer can choose a PolySwitch device with a trip current (Itrip) just below the maximum safe steady state current for the driver. In either case, the designer should conduct an empirical investigation to verify performance.

The RXE line of PolySwitch devices is rated for 50 or 60 volts rms and 40 amps rms maximum interrupt current. They are ideal for speaker applications.

Conclusion

PolySwitch devices provide a new and unique form of speaker protection. Their self-resettability and latching feature plus their economical cost, simplicity, safety, and increased system reliability make them well suited for this application.

Note: Detailed engineering design data for the RXE line can be obtained by requesting Data Sheet H52947.

For more information contact:

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PolySwitch Division

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Raychem

PolySwitch® Devices
Standard Product List

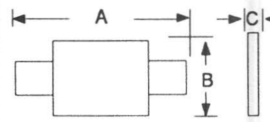
Part Number	Maximum Voltage	Rated Current (20°C) (amps) Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	Dimensions (inches) A	B	C

Diagram

Strap

These products provide reliable, noncycling protection for rechargeable batteries. Weldable nickel leads and a narrow, low-profile design make these devices extremely easy to install on the edges of battery packs.

Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
PRP120	15	1.20	2.31	50	0.17	UL, TUV	.91	.22	.04
PRP175	15	1.75	3.44	50	0.09	UL, TUV	1.10	.22	.04
SRP130	30	1.30	2.80	100	0.12	UL, TUV	.92	.27	.04
SRP150	30	1.50	3.30	100	0.09	UL, TUV	.92	.43	.04
SRP200	30	2.00	4.40	100	0.06	UL, TUV	.92	.43	.04
SRP350	30	3.50	6.30	100	0.03	UL, TUV	1.25	.53	.04
SRP420	30	4.20	7.60	100	0.02	UL, TUV	1.25	.53	.04

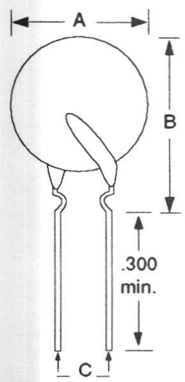


RXE

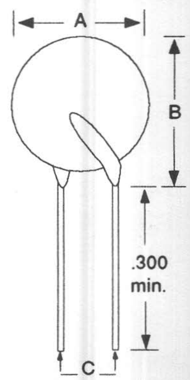
These products function as the general purpose line of circuit protectors and are well suited for power supplies, alarm systems, speakers, motors and many other applications. The RXE products range in hold currents from .10 to 3.75 amps and compliment our RUE devices by providing a higher voltage rating.

Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
RXE010*	60	0.10	0.20	40	4.50	UL,TUV,CSA	.29	.50	.2
RXE017*	60	0.17	0.34	40	5.21	UL,TUV,CSA	.29	.50	.2
RXE020*	60	0.20	0.40	40	2.84	UL,TUV,CSA	.29	.48	.2
RXE025*	60	0.25	0.50	40	1.95	UL,TUV,CSA	.29	.50	.2
RXE030*	60	0.30	0.60	40	1.36	UL,TUV,CSA	.29	.51	.2
RXE040*	60	0.40	0.80	40	0.86	UL,TUV,CSA	.30	.53	.2
RXE050*	60	0.50	1.00	40	0.77	UL,TUV,CSA	.31	.54	.2
RXE065*	60	0.65	1.30	40	0.48	UL,TUV,CSA	.38	.57	.2
RXE075*	60	0.75	1.50	40	0.40	UL,TUV,CSA	.41	.60	.2
RXE090*	60	0.90	1.80	40	0.31	UL,TUV,CSA	.46	.62	.2
RXE110	50	1.10	2.20	40	0.25	UL,TUV,CSA	.51	.71	.2
RXE135	50	1.35	2.70	40	0.19	UL,TUV,CSA	.57	.77	.2
RXE160	50	1.60	3.20	40	0.14	UL,TUV,CSA	.64	.84	.2
RXE185	50	1.85	3.70	40	0.12	UL,TUV,CSA	.70	.90	.2
RXE250	50	2.50	5.00	40	0.08	UL,TUV,CSA	.84	1.04	.4
RXE300	50	3.00	6.00	40	0.06	UL,TUV,CSA	.98	1.18	.4
RXE375	50	3.75	7.50	40	0.05	UL,TUV,CSA	1.12	1.3	.4

*denotes product available tape and reel per EIA RS-468



RXE010-RXE090



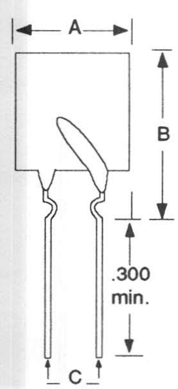
RXE110-RXE375

RUE

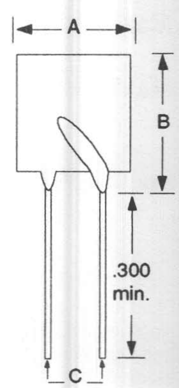
These devices are also designed to be used in a wide variety of general electronics applications. They compliment the RXE line by providing a smaller form factor with lower resistance and higher hold current capability (up to 9 amps).

Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
RUE090*	30	0.90	1.80	40	0.12	UL, CSA	.26	.48	.2
RUE110*	30	1.10	2.20	40	0.10	UL, CSA	.26	.56	.2
RUE135*	30	1.35	2.70	40	0.08	UL, CSA	.35	.53	.2
RUE160*	30	1.60	3.20	40	0.07	UL, CSA	.35	.60	.2
RUE185*	30	1.85	3.70	40	0.06	UL, CSA	.40	.62	.2
RUE250*	30	2.50	5.00	40	0.04	UL, CSA	.45	.72	.2
RUE300	30	3.00	6.00	40	0.05	UL, CSA	.45	.68	.2
RUE400	30	4.00	8.00	40	0.03	UL, CSA	.55	.79	.2
RUE500	30	5.00	10.00	40	0.03	UL, CSA	.55	.98	.4
RUE600	30	6.00	12.00	40	0.02	UL, CSA	.65	.98	.4
RUE700	30	7.00	14.00	40	0.02	UL, CSA	.75	1.05	.4
RUE800	30	8.00	16.00	40	0.02	UL, CSA	.85	1.15	.4
RUE900	30	9.00	18.00	40	0.01	UL, CSA	.95	1.17	.4

*denotes product available tape and reel per EIA RS-468



RUE090-RUE250



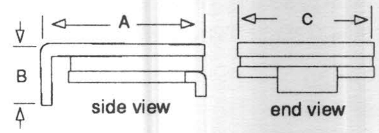
RUE300-RUE900

Part Number	Maximum Voltage	Rated Current (20°C) (amps) Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	Dimensions (inches) A	B	C	Diagram

SMD

This product line is specifically designed for surface mount applications. The products range in hold currents from 0.3 amps to 2.5 amps and voltages from 15 volts to 60 volts. These devices are ideally suited for high density board applications in computer and computer peripheral products, telecommunications and general electronics applications. They are designed to be reflowed onto a PCB using standard surface mount processes.

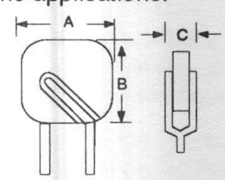
Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
SMD030	60	0.30	0.60	10	2.40	UL,CSA, TUV	.31	.125	.21
SMD050	60	0.50	1.00	10	0.70	UL,CSA, TUV	.31	.125	.21
SMD075	30	0.75	1.50	40	0.50	UL,CSA, TUV	.31	.125	.21
SMD100	30	1.10	2.20	40	0.24	UL,CSA, TUV	.31	.118	.21
SMD125	15	1.25	2.50	40	0.14	UL,CSA, PEND TUV	.31	.118	.21
SMD150	15	1.50	3.00	40	0.12	UL,CSA, TUV	.37	.118	.26
SMD200	15	2.00	4.00	40	0.080		.37	.118	.26
SMD250	15	2.50	5.00	40	0.065		.37	.118	.26



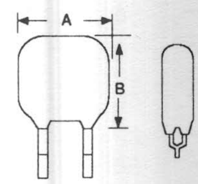
TR

This family uses a new geometry to build high voltage (250V-600V) products for telecommunications applications.

Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
TR250-120U	250	.120	.300	3	10.0	UL	.23	.23	.15
TR250-145U	250	.145	.360	3	6.5	UL	.23	.23	.15
TR250-180U	250	.180	.450	10	2.0	UL	.41	.26	.14



Part Number	Maximum Voltage	Hold	Trip	Max Current	Rmax Initial (ohms)	Recognized By	A	B	C
TR250-120	250	.120	.300	3	8.0	UL	.25	.25	.18
TR250-145	250	.145	.360	3	6.0	UL	.25	.25	.18
TR600-150	600	.150	.375	3	12.0	UL	.53	.35	.23



Definitions

Maximum Voltage: The highest voltage the device can withstand (in its tripped state) without damage.

Hold Current: The maximum continuous current that will not cause the device to trip at 20°C.

Trip Current: The minimum continuous current that will cause the device to trip at 20°C.

Maximum Current: The largest fault current, at rated voltage, the device can interrupt without being damaged.

Maximum R: Maximum non-tripped resistance of the device.

Caution: ***Operation beyond maximum ratings may result in device damage and possible electrical arcing and flame.***

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H53180 10/93

Raychem

- **High voltge rating**
- **Low hold currents**
- **Remotely resettable**
- **Latching operation**
- **Rugged, monolithic construction**

PolySwitch® RXE

R-line PTC Overcurrent Protection

Overcurrent, overtemperature protection
The PolySwitch circuit protector is a positive temperature coefficient (PTC) resistor that undergoes a large, abrupt change in resistance when an overcurrent or high temperature heats it above a specific point.

Normally just tens of milliohms, the resistance of the PolySwitch protector increases by orders of magnitude when the device is switched. This increase limits current to several milliamps.

Remotely resettable
The device will reset when voltage in the circuit is removed, or in some cases will reset automatically when the overload condition is corrected. Normal circuit operation can then be resumed. The protector requires no manual resetting or replacement.

Latching (noncycling) operation
After switching, the PolySwitch device is latched into its high-resistance, protective state by the small, sustained self-heating current. The protector will reset only after it has cooled and the fault condition has been corrected, thus avoiding continuous cycling that could cause circuit damage.

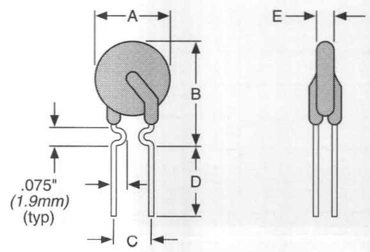
Rugged, monolithic construction
Since they are made from solid-state material, PolySwitch devices have no moving parts that can be damaged.

Wide variety of applications
Possible applications for PolySwitch RXE devices include:
- audio speakers
- batteries
- motors
- power supplies
- transformers
- solenoids
- PBXs
- telephones
- modems
- key telephone systems
- medical equipment
- test instruments
- industrial control circuits
- computers
- automotive small motor and electronics circuits

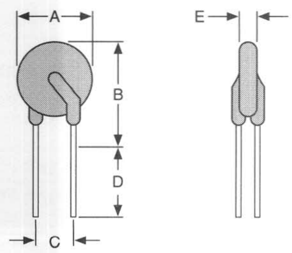
Product dimensions (inches/*millimeters*)

Part number	A max		B max		C typ		D min		E max	
RXE010	.29	*(7.4)*	.50	*(12.7)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE017	.29	*(7.4)*	.50	*(12.7)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE020	.29	*(7.4)*	.48	*(12.2)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE025	.29	*(7.4)*	.50	*(12.7)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE030	.29	*(7.4)*	.51	*(13.0)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE040	.30	*(7.6)*	.53	*(13.5)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE050	.31	*(7.9)*	.54	*(13.7)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE065	.38	*(9.7)*	.57	*(14.5)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE075	.41	*(10.4)*	.60	*(15.2)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE090	.46	*(11.7)*	.62	*(15.7)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE110	.51	*(13.0)*	.71	*(18.0)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE135	.57	*(14.5)*	.77	*(19.6)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE160	.64	*(16.3)*	.84	*(21.3)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE185	.70	*(17.8)*	.90	*(22.9)*	.20	*(5.1)*	.30	*(7.6)*	.12	*(3.0)*
RXE250	.84	*(21.3)*	1.04	*(26.4)*	.40	*(10.2)*	.30	*(7.6)*	.12	*(3.0)*
RXE300	.98	*(24.9)*	1.18	*(30.0)*	.40	*(10.2)*	.30	*(7.6)*	.12	*(3.0)*
RXE375	1.12	*(28.4)*	1.32	*(33.5)*	.40	*(10.2)*	.30	*(7.6)*	.12	*(3.0)*

RXE010-RXE090



RXE110-RXE375



Operating characteristics

Maximum voltage	60 V (RXE010–RXE090); 50 V (RXE110–RXE375)
Maximum interrupt current	40 amps
Operating/Storage temperature range	-40°C to 85°C
Typical reset time	<20 seconds (at 20°C) after power removed
Maximum surface temperature*	125°C in tripped state
Device resistance in tripped state*	V^2/P_d

* Note: Device will reset when $V^2/4R_L < P_d$ (R_L = load resistance, V = circuit voltage, P_d = power dissipated in tripped state)

Physical characteristics

Lead material	RXE017-040: 24 AWG, Sn-plated Fe
	RXE010, RXE050-090: 24 AWG, Sn-plated Cu
	RXE110-375: 20 AWG, Sn-plated Cu
Insulating material	Cured, flame-retardant epoxy polymer, meets UL 94V-0 requirements
Soldering characteristics	Solderability per MIL-STD-202, Method 208E
	Solder heat withstand per MIL-STD-202, Method 210, Condition B

Electrical characteristics (20°C)

Part number	I_H (amps)	I_T (amps)	Max time to trip @ 5 x I_H (sec)	P_d typ (watts)	Initial resistance R min (ohms)	Initial resistance R max (ohms)	Post trip resistance R_1 max
RXE010	0.10	0.20	4.0	0.38	2.50	4.50	7.50
RXE017	0.17	0.34	3.0	0.48	3.30	4.85	8.00
RXE020	0.20	0.40	2.2	0.41	1.83	2.67	4.40
RXE025	0.25	0.50	2.5	0.45	1.25	1.83	3.00
RXE030	0.30	0.60	3.0	0.49	0.88	1.27	2.10
RXE040	0.40	0.80	3.8	0.56	0.55	0.81	1.29
RXE050	0.50	1.00	4.0	0.77	0.50	0.75	1.17
RXE065	0.65	1.30	5.3	0.88	0.31	0.46	0.72
RXE075	0.75	1.50	6.3	0.92	0.25	0.39	0.60
RXE090	0.90	1.80	7.2	0.99	0.20	0.34	0.47
RXE110	1.10	2.20	8.2	1.50	0.15	0.21	0.38
RXE135	1.35	2.70	9.6	1.70	0.12	0.18	0.30
RXE160	1.60	3.20	11.4	1.90	0.09	0.14	0.22
RXE185	1.85	3.70	12.6	2.10	0.08	0.12	0.19
RXE250	2.50	5.00	15.6	2.50	0.05	0.08	0.13
RXE300	3.00	6.00	19.8	2.80	0.04	0.06	0.10
RXE375	3.75	7.50	24.0	3.20	0.03	0.04	0.08

I_H = Hold current. The maximum current at which the device will not trip at 20°C.
I_T = Trip current. The minimum current at which the device will always trip at 20°C.
P_d = Typical power dissipation. Typical amount of power dissipated by the device when in tripped state in 20°C still air environment.
Rmin = Minimum device resistance at 20°C prior to tripping.
R_1 max measured 1 hour post trip.

Environmental specifications

Test	Test method	Conditions	Resistance change
Passive aging	Raychem PS300	70°C, 1000 hours	±5%
		85°C, 1000 hours	±5%
Humidity aging	Raychem PS300	85°C, 85% R.H., 1000 hours	±5%
Thermal shock	Raychem PS300	125°C, -55°C (ten times)	±5%
Solvent resistance	Raychem PS300, Method 215	MIL-STD-202, Method 215F	No change

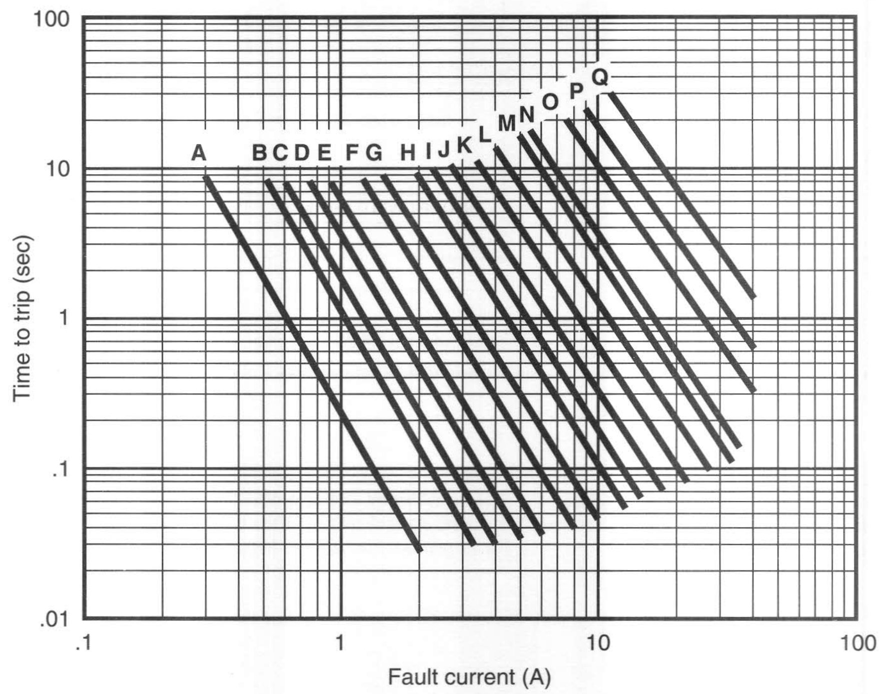
Approvals and reference documents

Agency approvals	UL-recognized component under file #E74889, thermistor type devices (X6PU2)
	CSA-recognized component under file CA 78165-1
	TUV-recognized component under file E88382.01
Reference documents	R-Line Selection Guidelines

Performance curves

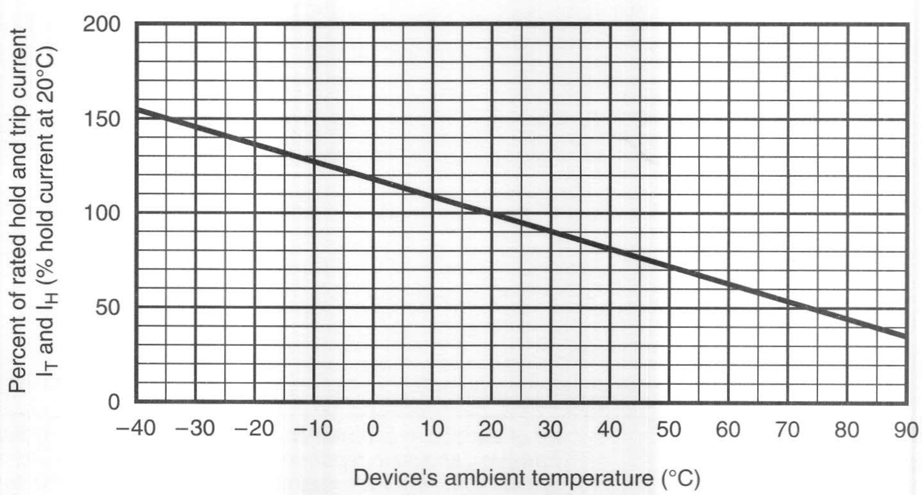
Typical time to trip at 20°C

A RXE010
B RXE017
C RXE020
D RXE025
E RXE030
F RXE040
G RXE050
H RXE065
I RXE075
J RXE090
K RXE110
L RXE135
M RXE160
N RXE185
O RXE250
P RXE300
Q RXE375



Example: The typical time to trip of RXE050 at 5 A is 0.3 seconds.

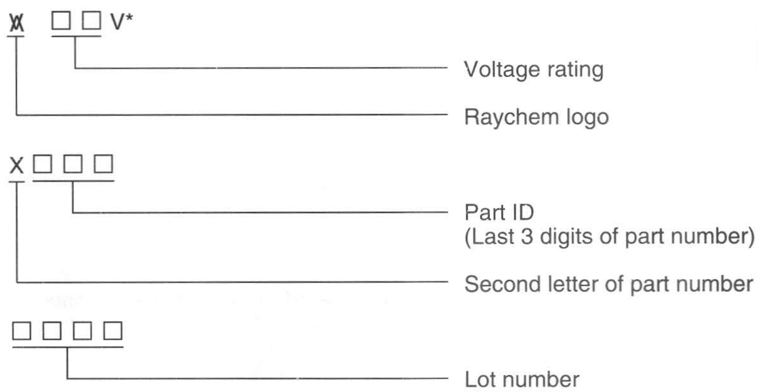
Thermal derating



Ordering information

Packaging	
Bulk	Product supplied in bags; 500 piece multiples
Tape and reel	RXE010 through RXE090 available tape and reel per EIA RS-468
Order number	RXE XXX

Part Marking



*V marked on for RXE065 and larger

Warnings

Caution:
Operation beyond maximum ratings may result in rupture of the device and possible electrical arcing and flame.

Note:
These devices are intended for overcurrent/undertemperature protection, not for continual, repeated tripping.

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Raychem

- Small size
- Low resistance
- High hold currents
- Remotely resettable
- Latching operation
- Rugged, monolithic construction

PolySwitch® RUE

R-Line PTC
Overcurrent Protection

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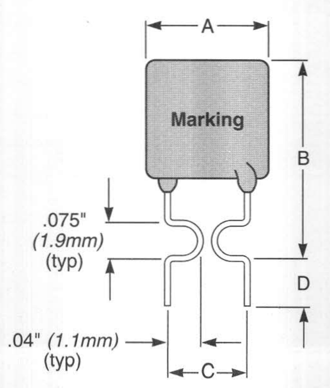
Wide variety of applications
Possible applications for PolySwitch devices include:
- audio speakers
- batteries
- motors
- power supplies
- transformers
- solenoids
- PBXs
- telephones
- modems
- key telephone systems
- medical equipment
- test instruments
- industrial control circuits
- computers
- automotive small motor and electronics circuits

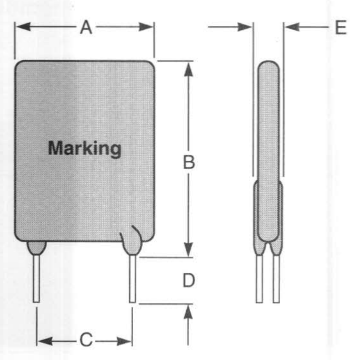
Product dimensions (inches/*millimeters*)

Order number	A max.	B max.	C typ.	D min.	E max.
RUE090	.26 (*6.6*)	.48 (*12.2*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE110	.26 (*6.6*)	.56 (*14.2*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE135	.35 (*8.9*)	.53 (*13.5*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE160	.35 (*8.9*)	.60 (*15.2*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE185	.40 (*10.2*)	.62 (*15.7*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE250	.45 (*11.4*)	.72 (*18.3*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE300	.45 (*11.4*)	.68 (*17.3*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE400	.55 (*14.0*)	.79 (*20.1*)	.20 (*5.1*)	.30 (*7.6*)	.12 (*3.0*)
RUE500	.55 (*14.0*)	.98 (*24.9*)	.40 (*10.2*)	.30 (*7.6*)	.12 (*3.0*)
RUE600	.65 (*16.5*)	.98 (*24.9*)	.40 (*10.2*)	.30 (*7.6*)	.12 (*3.0*)
RUE700	.75 (*19.1*)	1.05 (*26.7*)	.40 (*10.2*)	.30 (*7.6*)	.12 (*3.0*)
RUE800	.85 (*21.6*)	1.15 (*29.2*)	.40 (*10.2*)	.30 (*7.6*)	.12 (*3.0*)
RUE900	.95 (*24.1*)	1.17 (*29.7*)	.40 (*10.2*)	.30 (*7.6*)	.12 (*3.0*)

RUE090-RUE250



RUE300-RUE900



Operating characteristics

Maximum voltage	30 V
Maximum interrupt current	40 amps
Operating/Storage temperature range	-40°C to 85°C
Maximum surface temperature:	125°C in tripped state
Typical reset time	<20 seconds (at 20°C), after power removed
Device resistance in tripped state*	V^2/Pd

***Note:** Device will reset when $V^2/4R_L < P_d$ (R_L =load resistance, V=circuit voltage,Pd=power dissipated in tripped state).

Physical characteristics

Lead material	RUE090-250 24 AWG Sn-plated Fe
	RUE300-900 20 AWG Sn-plated Cu
Soldering characteristics	Solderability per MIL-STD-202, Method 208E
	Solder heat withstand per MIL-STD-202, Method 210, Condition B
Insulating material	Cured, flame-retardant epoxy polymer, meets UL94V-O requirements

Electrical characteristics (20°C)

Order Number	I_H[1] (amps)	I_T[2] (amps)	Max. time to trip @ $5 \times I_H$ (sec)	P_d typ.[3] (watts)	Initial resistance R min[4] (ohms)	Initial resistance R max (ohms)	Post trip resistance R_1 max[5]
RUE090	0.90	1.80	5.9	0.6	0.070	0.12	.22
RUE110	1.10	2.20	6.6	0.7	0.050	0.10	.17
RUE135	1.35	2.70	7.3	0.8	0.040	0.08	.13
RUE160	1.60	3.20	8.0	0.9	0.030	0.07	.11
RUE185	1.85	3.70	8.7	1.0	0.030	0.06	.09
RUE250	2.50	5.00	10.3	1.2	0.020	0.04	.07
RUE300	3.00	6.00	10.8	2.0	0.020	0.05	.08
RUE400	4.00	8.00	12.7	2.5	0.010	0.03	.05
RUE500	5.00	10.00	14.5	3.0	0.010	0.03	.05
RUE600	6.00	12.00	16.0	3.5	0.005	0.02	.04
RUE700	7.00	14.00	17.5	3.8	0.005	0.02	.03
RUE800	8.00	16.00	18.8	4.0	0.005	0.02	.02
RUE900	9.00	18.00	20.0	4.2	0.005	0.01	.02

1 I_H=Hold current. The maximum current at which the device will not trip at 20°C.
2 I_T=Trip current. The minimum current at which the device will always trip at 20°C.
3 P_d= Typical power dissipation: typical amount of power dissipated by the device when in tripped state in 20°C still air environment.
4 Rmin=Minimum device resistance at 20°C prior to tripping
5 R_1 max measured 1 hour post trip.

Environmental specifications

Test	Test method	Conditions	Resistance change
Passive aging	Raychem PS300	70°C, 1000 hours	±5%
		85°C, 1000 hours	±5%
Humidity aging	Raychem PS300	85°C, 85% R.H., 1000 hours	±5%
Thermal shock	Raychem PS300	125°C, -55°C (ten times)	±5%
Solvent resistance	Raychem PS300, Method 215	MIL-STD-202, Method 215F	No change

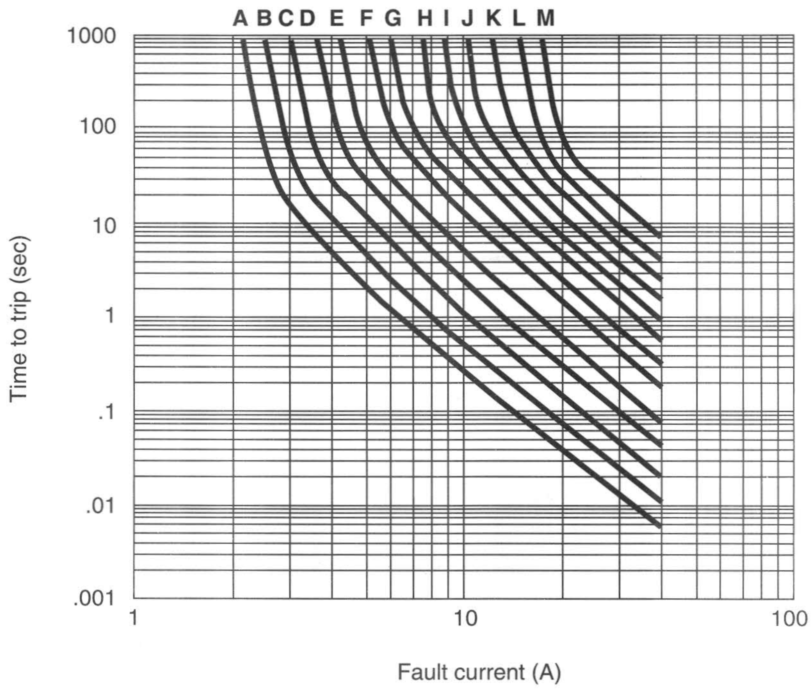
Approvals and reference documents

Agency approvals	UL-recognized component under file #E74889, thermistor type devices (X6PU2)
	CSA component acceptance pending under file CA 78165-1
Reference documents	R-Line Selection Guidelines

Performance curves

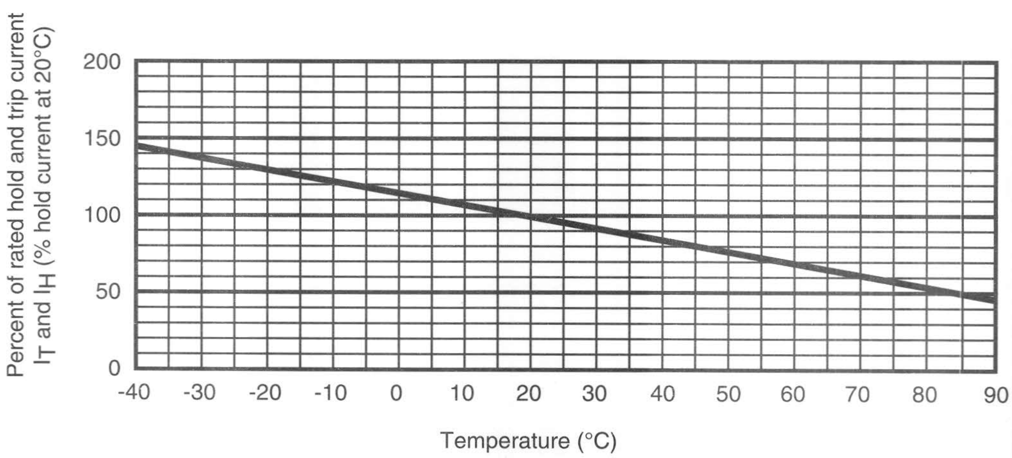
Typical time to trip @ 20°C

A RUE090
B RUE110
C RUE135
D RUE160
E RUE185
F RUE250
G RUE300
H RUE400
I RUE500
J RUE600
K RUE700
L RUE800
M RUE900



Example: The typical time to trip of RUE110 at 8 A is 1 second.

Thermal derating

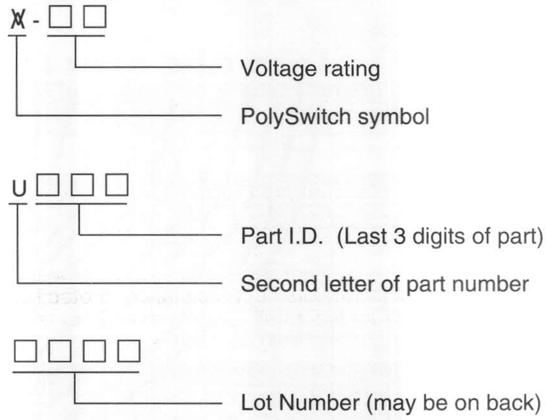


Example: At 65°C, the hold current of an RUE300 is 2.1 A and the trip current is 4.2 A — 70 percent of their rated values

Ordering information

Packaging	
Bulk	Product supplied in bags, 500 piece multiples
Tape and reel	RUE090 through RUE250 available tape and reel per EIA RS-468.
Order number	RUEXXX

Part marking



Caution

Operation beyond maximum ratings may result in device damage and possible electrical arcing and flame.

Note:
These devices are intended for over-current/undertemperature protection, not for continual, repeated tripping.

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Raychem

- **Remotely resettable**
- **Latching operation**
- **Easy to install**
- **Variety of applications**

PolySwitch® SMD

Surface mount devices
PTC overcurrent protection

Overcurrent protection
The PolySwitch circuit protector is a positive temperature coefficient (PTC) resistor that undergoes a large, abrupt change in resistance when an overcurrent or high temperature heats it above its transition temperature.

Normally just tenths of an ohm, the resistance of the PolySwitch protector increases by several orders of magnitude when switched. This increase limits the circuit current to milliamps.

Remotely Resettable
The device will reset when voltage in the circuit is removed or in some cases will reset automatically when the overload condition is corrected. Normal circuit operation can then be resumed. The protector requires no manual resetting or replacement.

Latching (noncycling) operation
After switching, the PolySwitch device is latched into its high-resistance, protective state by the small, sustained self-heating current. The protector will reset only after it has cooled and the fault condition has been corrected, thus avoiding continuous cycling that could cause circuit damage.

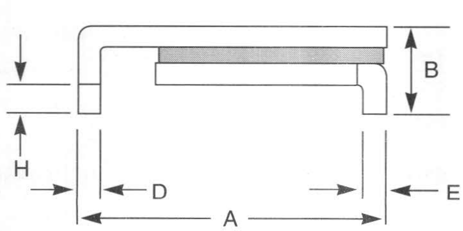
Variety of applications
Possible applications for PolySwitch devices include:
- Computers and peripherals
- PBX, KTS systems
- Electronic instruments
- Alarm systems
- Power supplies
- Local area networks
- Disk drives
- Printers

Product dimensions (inches *(millimeters)*)*

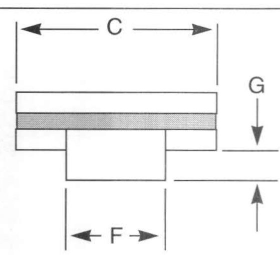
Order number	A min.	A max.	B max.	C max.	D min.	D max.
SMD030	0.265 *(6.73)*	0.314 *(7.98)*	0.125 *(3.18)*	0.214 *(5.44)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD050	0.265 *(6.73)*	0.314 *(7.98)*	0.125 *(3.18)*	0.214 *(5.44)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD075	0.265 *(6.73)*	0.314 *(7.98)*	0.125 *(3.18)*	0.214 *(5.44)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD100	0.265 *(6.73)*	0.314 *(7.98)*	0.118 *(3.00)*	0.214 *(5.44)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD125	0.265 *(6.73)*	0.314 *(7.98)*	0.118 *(3.00)*	0.214 *(5.44)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD150	0.315 *(8.00)*	0.374 *(9.50)*	0.118 *(3.00)*	0.264 *(6.71)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD200	0.315 *(8.00)*	0.374 *(9.50)*	0.118 *(3.00)*	0.264 *(6.71)*	0.022 *(0.56)*	0.028 *(0.71)*
SMD250	0.315 *(8.00)*	0.374 *(9.50)*	0.118 *(3.00)*	0.264 *(6.71)*	0.022 *(0.56)*	0.028 *(0.71)*

Order number	E min.	E max.	F min.	F max.	G min.	G max.	H min.
SMD030	0.022 *(0.56)*	0.028 *(0.71)*	0.085 *(2.16)*	0.095 *(2.41)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD050	0.008 *(0.20)*	0.012 *(0.30)*	0.085 *(2.16)*	0.095 *(2.41)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD075	0.022 *(0.56)*	0.028 *(0.71)*	0.085 *(2.16)*	0.095 *(2.41)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD100	0.022 *(0.56)*	0.028 *(0.71)*	0.085 *(2.16)*	0.095 *(2.41)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD125	0.022 *(0.56)*	0.028 *(0.71)*	0.085 *(2.16)*	0.095 *(2.41)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD150	0.022 *(0.56)*	0.028 *(0.71)*	0.145 *(3.68)*	0.155 *(3.94)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD200	0.022 *(0.56)*	0.028 *(0.71)*	0.145 *(3.68)*	0.155 *(3.94)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*
SMD250	0.022 *(0.56)*	0.028 *(0.71)*	0.145 *(3.68)*	0.155 *(3.94)*	0.026 *(0.66)*	0.054 *(1.37)*	0.017 *(0.43)*

* Rounded-off approximation.



Side view



End view

Operating characteristics

Operating/storage temperature	-40°C to 85°C
Maximum device surface temperature in tripped state	125°C*
Resistance in tripped state	V^2/Pd ohms**
Automatic reset condition	$V^2/4R_L <$ Pd*

Notes: *Temperature measured at contact point to printed circuit board will be lower.
**V = Voltage across device Pd = Power dissipation in tripped state

Physical characteristics

Lead material	Tin plated brass to MIL-T-10727B
Lead solderability	Meets EIA specification RS186-9E

Electrical characteristics

Order number	I_H (amps)	I_T (amps)	V max. (volts)	I max. (amps)	Pd max. (watts)	Maximum time to trip @ 5 x I_H (sec)	Initial resistance R min. (Ω)	Initial resistance R max. (Ω)	1 hr post reflow R_1 max. (Ω)
SMD030	0.30	0.6	60	10	1.7	3	1.20	2.40	4.8
SMD050	0.50	1.0	60	10	1.7	4	0.35	0.70	1.4
SMD075	0.75	1.5	30	40	1.7	4	0.35	0.50	1.0
SMD100	1.10	2.2	30	40	1.7	4	0.12	0.24	0.48
SMD125	1.25	2.5	15	40	1.7	5	0.07	0.14	0.25
SMD150	1.50	3.0	15	40	1.9	7	0.06	0.12	0.25
SMD200	2.0	4.0	15	40	1.9	12	0.05	0.08	0.15
SMD250	2.5	5.0	15	40	1.9	25	0.045	0.065	0.10

I_H = Hold current, maximum current device will pass without interruption in 20°C still air environment.
I_T = Trip current, minimum current that will switch the device from low resistance to high resistance in 20°C still air.
I max = Maximum fault current device can withstand without damage at rated voltage.
P_d = Power dissipated from device when in the tripped state in 20°C still air environment.
V max = Maximum voltage device can withstand without damage at rated current.
R_1 max measured 1 hour post reflow with reflow conditions of 260°C for 20 secs.

Environmental specifications

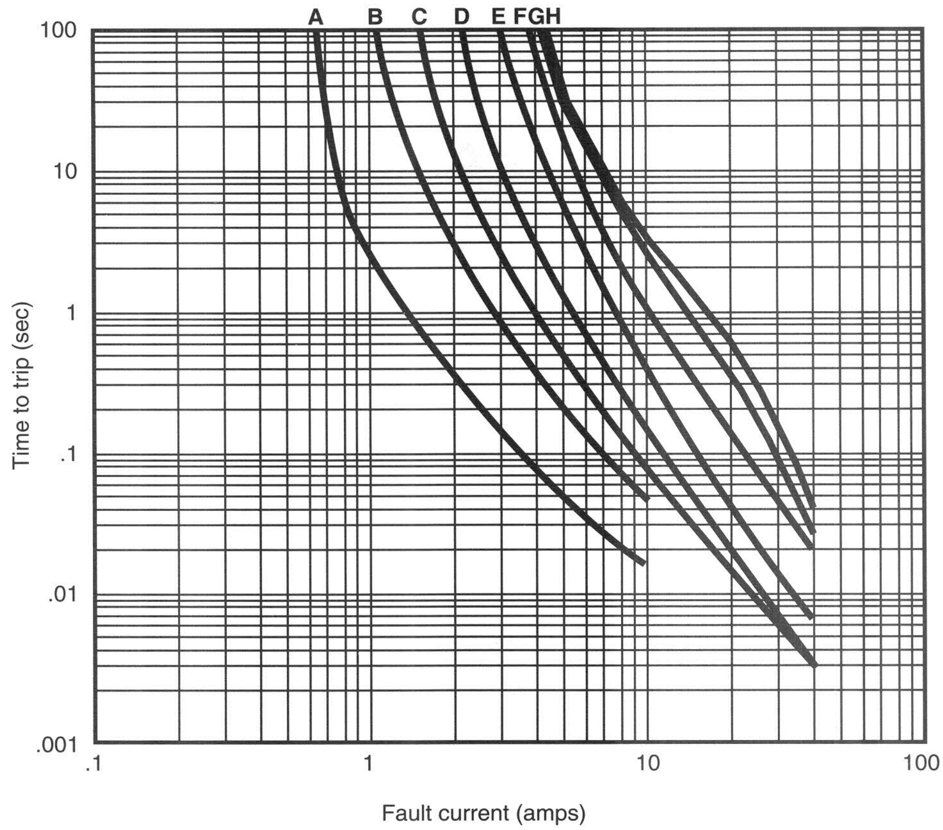
Test	Test method	Conditions	Resistance change
Passive aging	Raychem PS300 Section 5.3.2	70°C, 1000 hours	±2% typical
		85°C, 1000 hours	±5% typical
Humidity	Raychem PS300 Section 5.3.1	85°C, 95% R.H. 7 days	±5% typical
Thermal shock	MIL-STD-202 Method 107G	85°C, -40°C/20x	-3% typical
		125°C, -55°C/10x	-3% typical
Vibration	MIL-STD-883C	MIL-STD-883C	No change
Solvent resistance	Raychem PS300 Section 5.2.2 with the following solvents:	Freon	No change
		Trichlorofluoroethylene	No change
		Hydrocarbons	No change

Approvals and reference documents

Agency approvals	UL-recognized component under file #E74889, Thermistor Type Devices (XGPU2); CSA Component Acceptance under file CA 78165-1; TUV approval. UL and CSA approvals pending for SMD 200 and SMD 250.
Reference documents	PolySwitch SMD Installation Guidelines
	Application Bulletin: "Computer Applications of PolySwitch Devices"
	Engineering Note SMD 1.01, *"Principal characteristics of PolySwitch SMD Devices when reflowed."* PS300 Test Methods and Requirements for PolySwitch Devices.

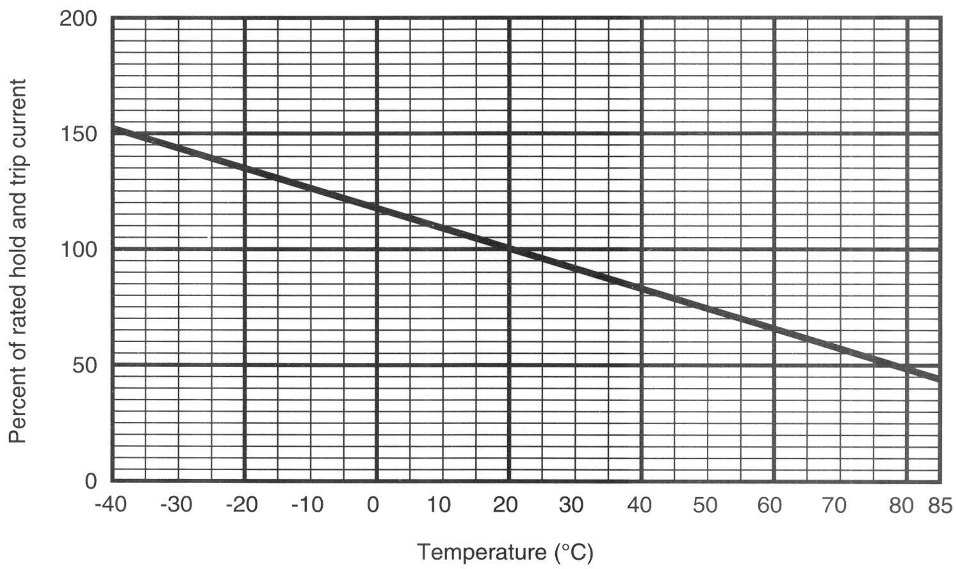
Performance curves

A SMD030
B SMD050
C SMD075
D SMD100
E SMD125
F SMD150
G SMD200
H SMD250



Typical trip time at 20°C

Example: The SMD125 will typically trip within .400 sec at a fault current of 10 A.

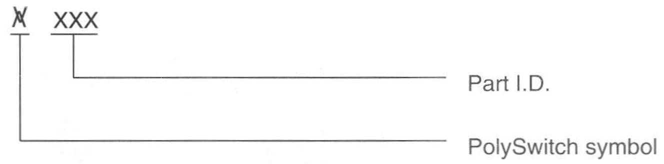


Thermal derating

Example: At 55°C, the hold current for a SMD125 is .875 A and the trip current is 1.75 A, which is 70% of their rated values.

Ordering information

Packaging	Packaged by tape-and-reel-carrier per EIA 481 standard.	
	Part	**Standard reel quantity**
	SMD030	2,000
	SMD050	2,000
	SMD075	2,000
	SMD100	2,000
	SMD125	2,000
	SMD150	1,500
	SMD200	1,500
	SMD250	1,500
	Order in multiples of standard reel quantity. Order number SMDXXX-2*. Minimum order quantity is 1 reel.	
	Part marking	



* -2 designates tape-and-reel packaging.

Caution

Operation beyond maximum ratings may result in device damage and possible electrical arcing and flame.

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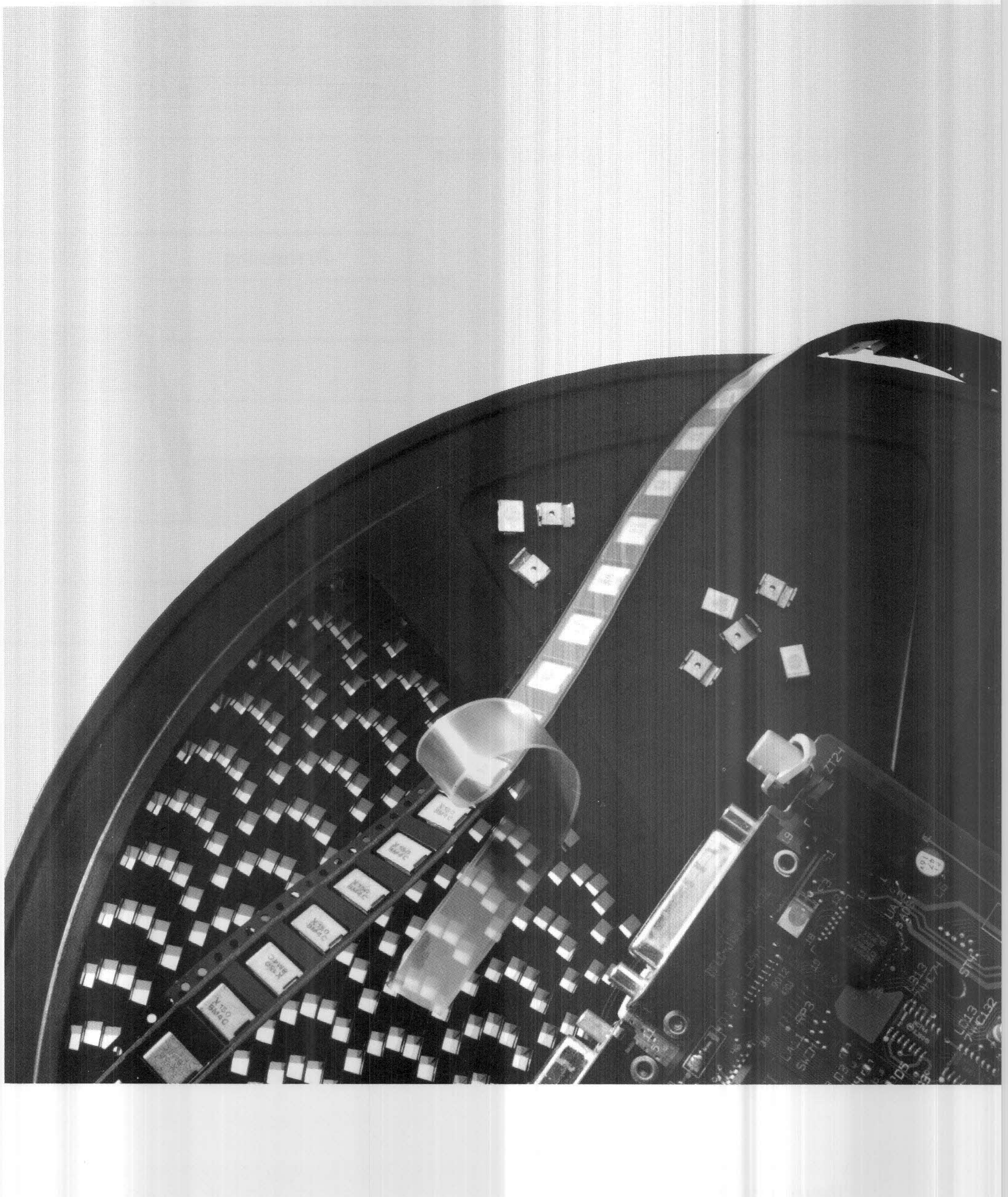
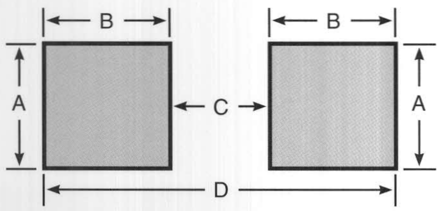
PolySwitch® SMD Installation Guidelines



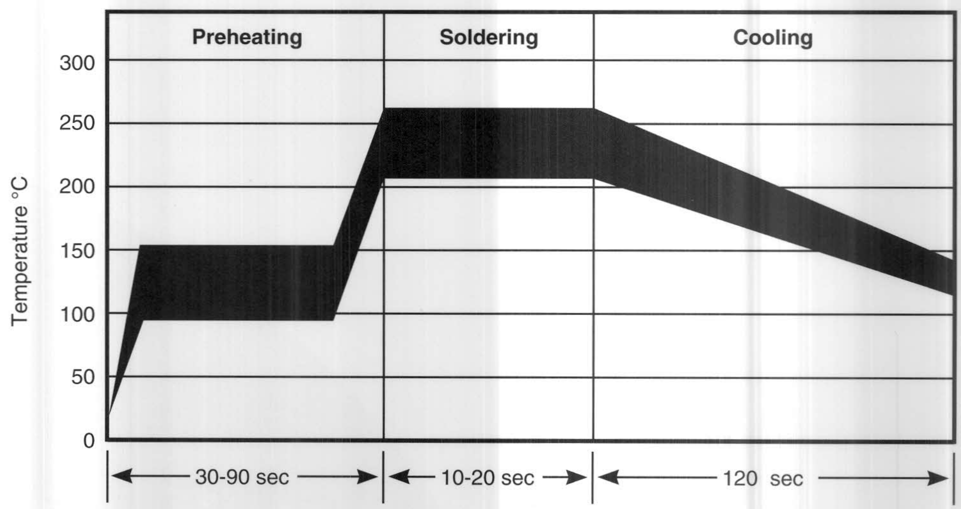
SMD Installation and Reflow Guidelines

Recommended pad layout (inches/*mm*)



Device	A nom	B nom	C nom	D nom
SMD030	.12 *(3.05)*	.08 *(2.03)*	.22 *(5.54)*	.38 *(9.65)*
SMD050	.12 *(3.05)*	.08 *(2.03)*	.22 *(5.54)*	.38 *(9.65)*
SMD075	.12 *(3.05)*	.08 *(2.03)*	.22 *(5.54)*	.38 *(9.65)*
SMD100	.12 *(3.05)*	.08 *(2.03)*	.22 *(5.54)*	.38 *(9.65)*
SMD125	.12 *(3.05)*	.08 *(2.03)*	.22 *(5.54)*	.38 *(9.65)*
SMD150	.18 *(4.57)*	.08 *(2.03)*	.26 *(5.59)*	.42 *(10.67)*
SMD200	.18 *(4.57)*	.08 *(2.03)*	.26 *(5.59)*	.42 *(10.67)*
SMD250	.18 *(4.57)*	.08 *(2.03)*	.26 *(5.59)*	.42 *(10.67)*

Recommended solder reflow conditions



Reflow methods and rework

Reflow methods
- IR, vapor phase oven, hot air oven.
- Devices are not designed to be wave soldered to the bottom side of the board.
- Gluing the devices is not recommended.
- Recommended maximum paste thickness is .010 inches.
- Devices can be cleaned using standard industry methods and solvents.
- If reflow temperatures exceed the recommended profile, devices may not meet the performance requirements.

Rework
- A device should not be reused after being reworked.
- If a soldering iron is used to replace device, heat should be applied only to the leads.

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